Time to Reevaluate Gender Segregation in Athletics?

Abstract

The case of Caster Semenya provides a vivid illustration of the ways in which natural genetic variation can generate large differences in athletic performance. But since we normally segregate athletic sports along the lines of this particular variation—gender—her case also highlights problems with the current approach to justice in sporting competition.

Female athletes seem to have a valid complaint when they are made to compete against athletes who are, in one sense or another, male. But once we recognize that gender is not a binary quantity, sex segregation in competitive sport must be seen as an inconsistent and unjust policy, no matter what stance we take on the goals of sport or on the regulation of doping.

Introduction

In the 2009 African Junior Championships, the women's 800 metres was won by the little-known South African athlete Caster Semenya, in a time of 1:56.72. She had improved markedly over the preceding year, and so the International Association of Athletic Federations (IAAF) tested her both for enhancing drugs and for being a man.

The drug test returned negative, but before the gender test could be completed, she won gold again at the World Championships in a time of 1:55.45. Though it was not a world record, it was a dominant victory over her opponents, and it represented another improvement of more than a second in her best time.

Her win was unexpected and dramatic, but what drew more attention was that the news of the gender test had leaked out before the race. So began the international question over whether her masculine physique had provided an unfair competitive advantage.

Elisa Piccione, who finished sixth, said 'For me she is not a woman'.[1] IAAF spokesman Nick Davies said in an unofficial statement to the Sydney Morning Herald that genetic tests were needed to show that Semenya was not benefiting from an 'unfair genetic advantage'.[2] The results of those tests have so far been kept confidential, and Semenya has reached an agreement with the IAAF which allows her to keep her medals and winnings, though it is unclear whether she will be allowed to continue competing as a woman, since the International Olympic Committee (IOC) is reviewing its guidelines for gender tests in January 2010.[3]

There are issues concerning Semenya's right to privacy and veiled racism which we acknowledge but won't explore here. We are also not interested in providing a definitive recommendation regarding what ought to be done in Semenya's case, since nobody

[1] Slot, O. 2009. Caster Semenya faces gender test after winning 800m. The Times. August 20, 2009.
[2] Magnay, J., Secret of Semenya's sex stripped bare, in Sydney Morning Herald. 2009, Fairfax: Sydney.
[3] Dahlberg, T. 2009. The Shameful case of Caster Semenya. Associated Press. November 21, 2009.

outside the IAAF and Athletics South Africa knows what the results of her tests were. What we're interested in is what her case means for anti-doping, for women's sports, and for competitive sports in general.

There are a number of factors which comprise a person's gender, which is why it is not as simple to determine whether an athlete is male or female as it is to determine whether or not she is on steroids. Males normally have an X and a Y chromosome, while women normally have two X chromosomes. Males normally have penises and testes while women normally have vaginas, uteri and ovaries. Males normally wear male clothing and identify as male, and women normally identify as female.

Importantly in the discussion of professional athletics, males normally have much higher levels of male sex hormones—testosterone in particular—while women have much lower levels of male sex hormones and higher levels of female hormones such as estrogen. This endocrinological issue is at the heart of the controversy surrounding Caster Semenya's athletic performance.

Testosterone is why we segregate sports.

When it comes to athletic sports, the fundamental reason for segregating men and women is virilization, the process by which an embryo develops into a phenotypic male rather than a woman. This process is driven by virilizing hormones or 'androgens', primarily testosterone.

Androgens have a range of effects on the primary and secondary sex characteristics of men and women during development and through adulthood—they encourage the growth of body hair and male sex organs, and inhibit the growth of breasts and other female sex characteristics. More importantly from a sporting perspective, they govern the growth of skeletal muscles, bones and red blood cells, each of which is of primary importance in determining athletic performance.

If men and women had the same levels of androgen hormones, there would be little reason to segregate sports into men's and women's leagues. We would have similar musculatures, similar haematocrit, similar sized breasts, and so forth.

But men normally have much higher levels of androgens than women throughout their lives. It is entirely because of this difference that we consider it unfair to expect women to compete with men in athletic sports. In sprinting, or rowing, or swimming, men perform at levels far beyond women, though both groups use the same equipment and training methods, and both groups work equally hard at their training. Men are larger, stronger and faster.

Anabolic steroids, the most famous and effective of all performance enhancing drugs, are an artificial form of testosterone aimed at mimicking the effect of naturally elevated testosterone levels. Just as it is considered unfair for women to compete against men, it

is considered unfair for people who are not on steroids to compete against those who are.

Of course, the question of whether someone is using steroids or not is a binary question: the answer is either ‘yes’ or ‘no’. The problem raised by Caster Semenya’s case is that the question of whether someone is male or female does not always have a binary answer.

Gender is not a binary quantity, in terms of testosterone and other androgens.

There are three different genetic causes which affect a woman’s ‘natural’ testosterone levels.

1) Intersex conditions

Simply sorting people by sex chromosomes into XX and XY groups will not be solve the problem highlighted by Semenya’s case. Leave aside the issue of whether it is fair and just to tell a woman she is male when she has spent her whole life living as a woman. Leave aside, too, the issue of whether or not we can justify compelling her to take a genetic test. The problem is that there are XX people who look and run like men, and XY people who look and run like women.

There are many such ‘intersex’ conditions; most will decrease a male’s performance in athletic sports, but only a few are likely to enhance a female’s performance.

When a genetic male, with X and Y chromosomes suffers from Androgen Insensitivity Syndrome (AIS) his body cannot respond in the normal way to androgens such as testosterone. A number of distinct mutations lead to AIS, and so there is a spectrum of cases. Some will be born with a vagina but no uterus or ovaries. Others will appear male externally but produce less testosterone and fewer sperm. If the person’s body looks entirely female from the outside, then they are mostly incapable of metabolizing testosterone, which means it provides little sporting advantage. But in a range of cases, people with AIS can produce and use more testosterone than the average female, while still bearing an externally female appearance.

In September 2009, the Daily Telegraph newspaper in Sydney reported that Caster Semenya had internal testes and no womb or ovaries.[4] The IAAF has refused to confirm or deny this report, but if it were correct, this would be indicative of AIS.

One simple way to solve this kind of case would be to declare that anyone with XY chromosomes must compete as a male, and that the AIS-afflicted would simply be

[4] Hurst, M. 2009. Caster Semenya has male sex organs and no womb or ovaries. The Daily Telegraph (Sydney), September 11, 2009

classified as low-performing males for the purposes of athletic competition. Between 1966 and 1999, this was the solution adopted in international athletics. [5]

But there are other genetic possibilities which muddy the waters even further, making this simple division unsatisfactory. Even in the unlikely event that nobody has yet competed with the aid of these genetic conditions, someone eventually will.

Females with the genetic condition known as Congenital Adrenal Hyperplasia (CAH) have two X chromosomes, but in some cases have abnormally high levels of androgen hormones. Depending on the exact mutation, CAH can generate a range of external appearances, from completely female to substantially male.

CAH occurs in around 1 in every 16,000 births worldwide, but in some populations it can be as high as 1 in 400.[6] In around half of these cases, CAH also causes salt-wasting, which can impede the body's growth.[7] But when CAH occurs without salt-wasting, it can lead to the development of unusually high muscle strength.[8] While women with this form of CAH are clearly female according to the simple genetic test, they may perform substantially better than those who have normal genes. A simple chromosomal test would classify these performance-advantaged athletes as female, though they are fuelled by naturally produced steroids.

In some cases, the simple genetic test will just not be able to answer the question of whether someone is male or female. There are cases of people who are neither XX or XY. Some people absorb a fraternal twin in utero and have both XX and XY cells. Others, with a condition known as 'XX male syndrome', have two X chromosomes due to an abnormal cell division in the early embryo. XX males have genes from the Y chromosome on one of their X chromosomes, making them appear male and develop male characteristics despite their female chromosomes. They have low testosterone compared to males, but high compared to females.

Each of these conditions leads to abnormalities in blood testosterone, and each can produce variations in external genitalia. They are relatively rare, but so are champion athletes. In any case, these cases of atypical gender—collectively known as 'intersex' conditions—are not as rare as we might ordinarily think they are.

How many of the great champions of women's athletics have had intersex conditions? Leonard Sax estimates that about 1 in 5500 people has an intersex condition in which the chromosomes do not match the phenotype, or where the phenotype is in between

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[5] Ljungqvist, A., Gender Verification, in Women in Sport, B. Drinkwater, Editor. 2000, Wiley-Blackwell: Oxford.
[6] Wilson, R.C. and M.I. New, *Congenital Adrenal Hyperplasia*, in *Principles of Molecular Medicine*, M.S. Runge and C. Patterson, Editors. 2006, Humana Press: New York. p. 365-376.
[7] Speiser PW, White PC. 2003. Medical Progress: Congenital adrenal hyperplasia. New Eng J Med 349:776-788
[8] Rodda C., Jones DA., Round J. and Grant DB. 2008. Muscle Strength in Girls with Congenital Adrenal Hyperplasia. Acta Paediatrica, 76(3):495-499

male and female.[9] The rate among athletes is much higher, since intersex women naturally succeed in athletics and rise to the top. Ferguson-Smith and Ferris estimate that 1 in 500-600 female athletes have a detectable intersex condition with an XY chromosome, such as AIS.[10] Many others will have an intersex conditions which, like CAH, confer an advantage without being detectable in a chromosome test.

Beginning in 1966, female athletes were been required to submit to tests for the presence of a Y chromosome. At the time, it was suspected that male athletes were posing as females in major sporting events. In 1996, the IOC passed a resolution to cease performing these tests because of the harm that they inflicted on athletes who tested positive, and testing stopped in 1999.[11] Results of these tests were mostly kept confidential, and those who tested positive tended to drop out of competition quietly. But the results that were published over the intervening 33 years shed some light on the prevalence of intersex conditions in the highest levels of athletics.

In the 1996 Olympics in Atlanta, eight of 3387 female athletes were found to be genetically male; seven of these eight had partial or complete AIS.[12] Over five Olympic Games, an average of one in every 421 female athletes was found to have a Y chromosome.[13] Of course, these results only scratch the surface of intersex conditions in sport, however, since they are incapable of detecting CAH-affected females or those with XX-male syndrome. Furthermore, the natural range of variation in testosterone and testosterone sensitivity suggests that a great many athletes have a genetic testosterone advantage without having an intersex condition.

In 1999 Amelie Mauresmo reached the final of the Australian Open despite entering unseeded. She would later go on to reach the number-one ranking, but at the time all eyes were on her masculine appearance. Her opponent in the final, Martina Hingis, called her ‘half a man’.[14] Mauresmo has never been accused of taking artificial testosterone, having an intersex condition, or of actually being a man in any sense. But what if it turned out that she had naturally elevated levels of testosterone?

Not all intersex women will be excellent athletes. Athletics also depends on various other biological systems such as development of the heart and lungs, as well as neurological factors like coordination. However, it is an inevitability that some athletes will benefit in their sporting performance from intersex-related conditions.

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[9] Sax, L., How common is intersex? A response to Anne Fausto-Sterling. The Journal of Sex Research, 2002. 39(3): p. 174-178.
[10] Ferguson-Smith, M.A. and E.A. Ferris, Gender verification in sport: the need for change? Br J Sports Med, 1991. 25(1): p. 17-20.
[11] Ljungqvist, A., Gender Verification, in Women in Sport, B. Drinkwater, Editor. 2000, Wiley-Blackwell: Oxford.
[12] Simpson, J.L., et al., Gender verification in the Olympics. JAMA, 2000. 284(12): p. 1568-9.
[13] Ferguson-Smith, M., Gender verification and the place of XY females in sport. , in Oxford Textbook of Sports Medicine., M. Harries, et al., Editors. 1998, Oxford University Press: Oxford. p. 355-365.
[14] Hinds, R. 1999. Mauresmo Muscles into Final. *Sydney Morning Herald*, Jan 29 1999, Sport 32.

It will be as though they have taken steroids, except that like Caster Semenya they have not broken any rules. Given that only a handful of female athletes is caught taking anabolic steroids in any given year, we should assume that the results of a number of elite and amateur sporting results will hinge on this type of genetic advantage.[15]

2) Baseline genetic variation.

Elevated testosterone is not the only factor which can produce a genetic elevation in sporting performance. Successful athletes are born with a range of advantageous genes, some of which affect the expression of testosterone and some of which do not.

These natural variations in sporting performance have sometimes been a source of discontentment. The New York City marathon, dominated in its early years by white American runners, was not won by an American of any colour from 1982 to 2009. In 2009, an American citizen finally reclaimed the title, but because he was born in Eritrea, many felt the victory was not an authentic American one. As one commentator put it, 'Nothing against Keflezighi, but he's like a ringer who you hire to work a couple hours at your office so that you can win the executive softball league'.[16] The implication is that Americans are not competing in the same league as Eritreans when it comes to long-distance running.

It is true that there is a perception that athletes of African descent have, on balance, a greater genetic endowment for athletics than Europeans or Asians. It is still unclear if this is the case. African American women do not appear to have significantly higher serum testosterone than whites,[17] and some authors have gone so far as to suggest that the perceived advantages held by African or African American athletes have little to do with biology.[18]

Even if that is true, there are undeniably enormous regional and local variations in the genetic talent of athletes.[19] Some regions produce athletes with a higher proportion of fast-twitch muscle fibers, or a higher proportion of tall or heavy athletes, or athletes with more efficient skeletal muscles. Within any given region, the variation in serum testosterone between individuals is extremely high, and 57% of this variation is caused by genetic factors.[20] There are also strong genetic variations in sex hormone binding globulin (SBHG) which transports sex hormones to the muscle tissues and thus affects

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[15] WADA Annual Report 2008. 2008, World Anti-Doping Agency: Montreal.
[16] Kolata, G. 2009. To Some, Winner Is Not American Enough. New York Times, Nov 2 2009.
[17] Manson JM, Sammel MD, Freeman EW, Grisso JA. 2001. Racial differences in sex hormone levels in women approaching the transition to menopause. Fertility and Sterility 75(2):297-304
[18] Harrison CK, Lawrence SM. College Students' Perceptions, Myths, and Stereotypes about African American Athleticism: A Qualitative Investigation. Sport, Education and Society. 2004;9(1):33-52.
[19] Ostrander EA, Huson HJ, Ostrander GK. Genetics of athletic performance. Annu Rev Genomics Hum Genet. 2009;10:407-29.
[20] Ring HZ, Lessov CN, Reed T, Marcus R, Holloway L, Swan GE, et al. Heritability of plasma sex hormones and hormone binding globulin in adult male twins. J Clin Endocrinol Metab. 2005 Jun;90(6):3653-8.

their effectiveness. Any one of these genetic variations, in athletic sports, can become the major determinant of who wins and who loses.

No reasonable person would suggest that we should begin to segregate sporting competition into racially or genetically separate leagues as we do with gender segregation. To even suggest this would seem to deny the legitimacy of the winners' achievements. But the reason we segregate men from women in sport is presumably to allow women some chance to win an event, when their genetic inheritance would prevent them from doing so when competing against the men. How are we to reconcile this disparity in policy?

What should we do?

It is easy to understand why other female competitors would see Semenya's presumably elevated testosterone as an unfair advantage. She can attain a level of speed in sprinting which few of them will ever be able to attain, perhaps making their hopes of victory futile as long as she remains in competition. A random variation in biology has robbed them of the opportunity to win.

If we understand the gender segregation rules in sport in purely genetic terms, depending on the undisclosed results of her gender test, Semenya may have (perhaps unwittingly) broken the rules when she competed in the women's division. However, for the reasons we gave above, there will be, and almost certainly have already been, champions who are genetically female but whose intersex conditions provide them with a sufficient advantage to put victory out of the reach of other competitors.

Such an athlete would break no rules when she elected to compete with other women. She would train hard, and sacrifice much, just like the others. And just like the Africans who win the marathon in New York time after time, her victories would be authentic and valid in every sense.

If, on the other hand, we understand the segregation rules according to their intent—that is, to eliminate unfair variance in performance due to genetic variance in androgens—then we ought consider it a violation of the rules when a genetically female athlete with an intersex condition wins an event.

Our response to this violation need not be to try to remove these people from competition. It remains an open question whether gender segregation is ever a just policy in athletics. Intersex competitors give real practical importance to this question.

There are two positions on what sport is, and the position we take will govern our response to cases where gender is not 100% male or 100% female.

1) Athletics is a test of potential

The first of these positions states that the point of athletics is to reveal the natural,

unaltered potential of athletes. We have argued that this view is unrealistic, since training, equipment and diet all serve to overcome the natural limitations of athletes. But Caster Semenya's case has presented a bigger problem for this view.

If we are committed to the idea that athletic sport tests natural potential, then the winners should be those with the most fortuitous place of birth, the best gestational environment, and above all, those with the most advantageous genes.

On this view you should never exclude anyone just because they have some advantageous genetic variant. If you did, you would need to exclude many champion athletes like Michael Phelps (who has Marfan's syndrome, giving him greater armspan) and Ian Thorpe (who has big feet).

More importantly, if athletics is about revealing natural potential, we will need to reject the policy of segregating the men from the women, which divides athletes based entirely on genetic advantage. Why should Phelps be allowed to claim victory over Park Tae-Hwan, whose arms are shorter, when Usain Bolt is not allowed to compete against—and defeat—Caster Semenya?

Even leaving aside gender and genetic intersex conditions, there is a natural range of variation in every other genetic quantity which affects sporting performance. We mentioned above the large range of variation in testosterone, muscle and bone development. To take one particular example, the Finnish skier Eero Mäntyranta has a mutation in the erythropoietin receptor gene which causes him to have a naturally elevated hematocrit, as if he were taking the banned drug erythropoietin (EPO).[21]

Cycling's governing body, the International Cycling Union (UCI), has responded to such genetic variations in haematocrit by allowing the genetic mutants to compete, but by setting limitations on the maximum level of haematocrit, corresponding to the maximum level which is considered safe.[22] Cyclists are not allowed to use drugs to increase their haematocrit, but the key determinant of whether or not you can compete is your current level of haematocrit, whether it was obtained legally or illegally.

Thus one option for dealing with natural variation in testosterone would be to divide sports not along gender lines, but draw a limit based on the level of testosterone in athletes' blood. Above the limit, athletes would compete as 'men', no matter which chromosomes or sex organs they had. Below the limit, they would compete as 'women'. This would simply be a more determinate version of what we currently do when we divide athletics into men and women.

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[21] Siegel, F.P. and P.E. Petrides, Congenital and acquired polycythemias. Dtsch Arztebl Int, 2008. 105(4): p. 62-8.

[22] Kazlauskas, R., C. Howe, and G. Trout, Strategies for rhEPO detection in sport. Clin J Sport Med, 2002. 12(4): p. 229-35.

Unfortunately, this option presents some serious practical difficulties, since testosterone can confer benefits during development that remain even when the testosterone is gone. One could grow muscles as a man and then compete with low testosterone as a woman.

Another difficulty is that testosterone differs in its effectiveness depending on the sensitivity of an individual's testosterone receptors. Athletes with Androgen Insensitivity Syndrome will obtain little or no benefit from taking testosterone. But AIS is not the only genetic trait which affects testosterone receptor sensitivity—there are a range of genes which can affect androgen sensitivity to a less pronounced extent.

A 'hormonal level-playing field' would require not only an assay of athletes' androgen levels but also an assessment of the competence of their androgen receptors. That is, it would require some kind of test of the functionality of the androgens in vivo. This would be very difficult at present to do. But without such a test, it is impossible to tell how much advantage an athlete is gaining from her biology. If we segregate athletes using a simple testosterone test, we simply guarantee that the winners in the 'women's' league will be those with the most sensitive androgen receptors—probably genetic males with low serum testosterone.

There are also other difficulties deeper than these practical ones. If we ban people with high testosterone from competing as women, we create a situation where some people will be placed just slightly above this limit, instantly turning them from champions in the women's league to losers in the men's. They would go from earning tens of millions of dollars in prizes and endorsements, to being complete failures.

More importantly, some of the people who are placed above the limit for female competition will be able to make the reasonable objection that it is natural genetic variation which has placed them there. We will find ourselves in the unacceptable position of telling genetically talented, genetically female competitors that they must lose to the men rather than win against the women.

2) Sport is a test of hard work

The second of the two positions on sport is that athletics is supposed to test hard work, inspiration and effort. On this view the question of whether or not doping should be against the rules is an open one. If we want sport to be mainly about hard work, then it is unfair for the genetically gifted to defeat the hard-working genetically unlucky.

Elsewhere, we have recommended that sporting bodies allow doping within safe limits to redress unfair genetic variations.[23] This suggests a strategy for dealing with cases of talented intersex athletes.

[23] Savulescu, J., B. Foddy, and M. Clayton. 2004. Why we should allow performance enhancing drugs in sport. Br J Sports Med 38(6): 666-70.

The strategy would work much like the haematocrit rule in professional cycling. Rather than segregating athletics using testosterone, we would choose one safe target for testosterone for both men and women, and let athletes take exogenous testosterone (or testosterone antagonists) so that they can all reach that higher or lower level, eliminating the unfair genetic variation.

Unfortunately, the problem of variation in receptor sensitivity would again rear its head, since some people gain more benefit than others from the same level of exogenous testosterone.[24] In order to truly eliminate unfair testosterone-based advantage, we would need to adjust the target level for each athlete in light of their sensitivity to testosterone, and their SBHG levels, and so forth. Such a program is likely beyond the limits of current science, and is certainly impractical in leagues with tens of thousands of athletes.

Variation in receptor sensitivity also makes the identification of safe levels of testosterone very difficult. In professional cycling, it is enough to make sure that every cyclist has a haematocrit which is below the designated safe level. If everyone has the same haematocrit, then everyone gets the same sporting benefit, whether they achieve that level of haematocrit using drugs, altitude training or genetic advantage.

The same cannot be said for testosterone. Even if we identify a level of testosterone which is safe for some individuals, it will not be the case that everybody at that level will experience the same performance benefit. Athletes with AIS will be able to live safely with a higher level of testosterone in their blood, and they will also need that higher level of testosterone in order to obtain the same performance benefit. While we can theoretically determine an individualized safe, effective level of testosterone for each athlete based on his or her genes, this is not even remotely feasible.

But even if this strategy could be made workable, it would likely necessitate the elimination of gender segregation in sport. If the equalization of testosterone was sufficient to allow the equalization of performance between genders, then there would be no reasonable basis on which to prevent male athletes from competing in the women's leagues, and vice versa.

Tamburrini and Tannsjo have argued that women should be allowed to use genetic enhancements in order to eliminate the difference in testosterone, and become competitive with men at the elite level of athletics.[25] Whether genetic enhancements or anabolic steroids are used to equalize performance, there will be no valid rationale for segregating sport by gender if the performance levels are equalized.

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[24] Schulze, J.J., Rane, A. and Ekström, L. 2009. Genetic variation in androgen disposition: implications in clinical medicine including testosterone abuse. Expert Opinion on Drug Metabolism & Toxicology 5(7): 731-744

[25] Tamburrini, C. and T. Tannsjo, The genetic design of a new Amazon, in Genetic technology and sport: ethical questions, C. Tamburrini and T. Tannsjo, Editors. 2005, Routledge: New York. p. 181-198.

In any case, the majority view amongst sportspeople and regulators is that it is wrong to attempt to equalize performance. The majority think that athletics is not about maximizing absolute performance, but rather about maximizing the expression of individual talent, unaltered by drugs or 'unfair genetic advantage'.

Conclusion

Whichever of these two views about sport is correct, there is no justification for excluding an intersex athlete, perhaps like Caster Semenya, who has broken no rules, and whose only crime is that they are not at an extreme of the gender spectrum.

If we are to treat intersex athletes in a way that is just, we also will face a strong challenge to the current regime of gender segregation in sport, no matter which of these two views is correct. The current solution is to maintain gender segregation and disadvantage the intersexed. But that solution is inconsistent and unjust.

We have argued elsewhere that the best approach to doping in sport is to relax restrictions in sport, allowing doping which is safe and consistent with the spirit of a sport.[26,27] If we took this approach to the problem of intersex conditions, it would remove the need to test for intersex conditions, or for natural variations in androgen or androgen receptor sensitivity. However, it would not address the underlying complaint made against Caster Semenya by her opponents, who object to her genetic advantage.

What we decide to do about the various genetic advantages in testosterone production or metabolism depends on what we think the goals of athletic sport are. If athletics aims to identify natural potential, we should abolish gender segregation so as to recognize the potential of those who are intersexed or female with unusually high levels of androgens. If, on the other hand, athletics aims to reward the hardest worker, we need to try to eliminate the advantages conferred by variation in androgen levels—this too will ultimately require that we eliminate gender segregation, which currently gives an unfair advantage to those who qualify as just barely 'female'.

Whether we seek to redress these advantages or not, we should recognize that many injustices stem from the segregation of athletics by gender. So far, we have addressed this problem by pretending that there are only two genders, or that intersex conditions are exceedingly rare. But as Semenya's case demonstrates, we cannot maintain this pretense forever.

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[26] Savulescu, J. and B. Foddy, Ethics of Performance Enhancement in Sport: Drugs and Gene Doping.", in Principles of Health Care Ethics, R.E. Ashcroft, et al., Editors. 2007, John Wiley & Sons: London. p. 511-519.

[27] Savulescu, J., B. Foddy, and M. Clayton, Why we should allow performance enhancing drugs in sport. Br J Sports Med, 2004. 38(6): p. 666-70.